will be produced so long as the seeds are large enough to produce vigorous plants.

The farmer and the plant-breeder may plant the small potato tubers or the small seeds without any danger of deterioration in the yield and quality of the crop provided they select these tubers or seeds from plants which yield the largest quantity and the finest quality of tubers or of seeds.

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SOIL WATER IN RELATION TO TRANSPIRATION

By V. M. Spalding

In a recent article by the writer on the creosote bush in its relation to water supply,* the statement was made that the amount transpired appears to stand in direct relation to the amount of water available in the soil in which the plant is growing. Further observations on this and some other desert plants not only confirm this view but go to show that water in the soil is a controlling factor, and that even as efficient an agent as light may, in comparison, take quite secondary rank.

The later literature of transpiration, however voluminous in general, is extremely limited as regards this branch of the subject.† Aloi and Ferruzza have shown that the amount of water in the soil is a factor by which the opening of stomata, and consequently the rate of transpiration, is controlled, and Stenström has attempted to formulate a mathematical equivalency between the rate of transpiration and the ratio of atmospheric and soil moisture. The remaining literature dates from the works of Sachs and older writers.

In the summer of 1904, while engaged in observing the influence of light of different degrees of intensity on transpiration, I found that results apparently conflicting became consistent when account was taken of the amount of water supplied to the plants under investigation and the time at which it was given.

* Botanical Gazette, 38: 122. 1904.

† Burgerstein, A. Die Transpiration der Pflanzen, 137. 1904.

The plants employed were seedlings of the creosote bush (*Covillea*) and palo verde (*Parkinsonia Torreyana* and *P. aculeata*) growing in cans and supplied with measured quantities of water at stated intervals. The rate of transpiration was determined by placing the plants under a bell-jar, with suitable precautions to prevent the absorption or escape of water vapor, the amount of water transpired being derived from readings of a hygrometer. As details will be given elsewhere, a brief résumé of experiments and results will be sufficient for the present purpose.

Beginning with the palo verde, two sets of plants, one serving as a check on the other, were used. August 11, the plants having been well watered the day before, the rate of transpiration was determined. The following day, August 12, the plants meantime having received no water, but having been treated precisely as before, as regards light and other controllable conditions, the rate of transpiration was found to be only 52.6 and 38.5 per cent. as high as it was on the preceding day, a result apparently attributable to nothing else than the diminished quantity of water in the soil in which the plants were growing.

The same plants were again placed under observation August 18, having been given no water since August 15. External conditions were favorable to transpiration, full sunlight, a fresh breeze, and rather high temperature. At 11:40 A. M., after the rate of transpiration had been noted, number 1 was given one ounce, and number 2 three ounces of water. At 1:15 P. M., the rate of transpiration of number 1 was found to be the same as at the time of the preceding observation, while that of number 2 was twice as great. At 4 P. M., observations were again made, and at this second afternoon reading it was found that number 1 was transpiring twice and number 2 four times as rapidly as at the time of the forenoon observation.

The following forenoon the rate of transpiration of number 2 was found to be nearly four times as great as that of number 1, a striking difference when it is considered that only twenty-four hours earlier their rate had been the same, explainable, it would seem, only by recalling the fact that when the observations began on the morning of August 18, both sets of plants were in dry

soil, but on the following day number 2 had received three times as much water as number 1, and probably on account of sub-irrigation was able to utilize a greater percentage of what was given to it.

Experiments with *Covillea* gave even more striking results. September 5, the transpiration of two plants, designated 1 and 2, was determined in the forenoon between 11 and 12, and again in the afternoon between 3 and 4 o'clock. Number 2 was given three ounces of water at 12:20, none being given to number 1. At the time of the afternoon observation it was found that number 2 was transpiring more than three times as rapidly as it was before the water was given to it, and number 1, which was not watered, was transpiring only one-fifth as rapidly as it was in the forenoon.

Observations were also made for the purpose of ascertaining the effect of exposure to direct sunlight in conjunction with water supply. It was found that exposure to bright sunlight was uniformly followed by accelerated transpiration, whenever the plant under observation had a full supply of water, but that otherwise such acceleration did not take place.

It is noteworthy that plants which had all along received a meagre supply of water were nevertheless in a position to transpire rapidly when once a full supply of water was furnished them, while plants which from the beginning had received a very large amount of water showed promptly a marked lowering in rate of transpiration when the water supply was reduced.

With so complicated a problem general statements may well be made with extreme caution, but the evidence in the present case is sufficient to show that in studies of transpiration it is altogether unsafe to attempt to estimate any other factors whatever without taking due account of water in the soil.

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